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(71) Applicant: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
Kadoma-shi, Osaka 571-8501 (JP)

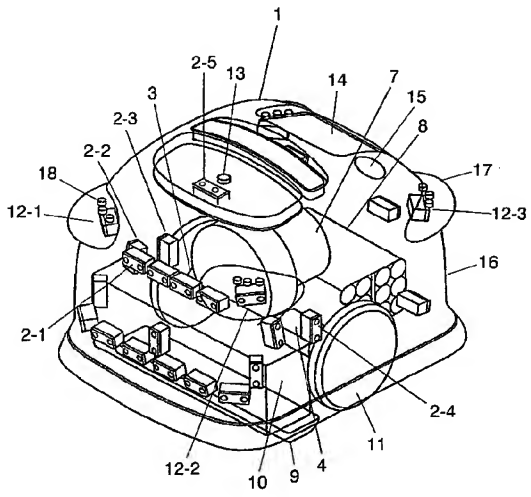
(72) Inventors:
- **Mori, Hiroshi**
  Yokaichi-shi, Shiga 527-0028 (JP)
- **Kato, Kiminori**
  Yokaichi-shi, Shiga 527-0051 (JP)
- **Ohara, Naoyuki**
  Yokaichi-shi, Shiga 527-0046 (JP)
- **Odachi, Toru**
  Gamo-gun, Shiga 520-2564 (JP)
- **Yabuuchi, Hidetaka**
  Takarzuka-shi, Hyogo 662-0033 (JP)
- **Kayama, Hiroyuki**
  Osaka-shi, Osaka 532-0002 (JP)
- **Yasuno, Miki**
  Hirakata-shi, Osaka 573-1173 (JP)
- **Haji, Masayo**
  Kawanishi-shi, Hyogo 666-0005 (JP)
- **Matsuyo, Tadashi**
  Yokaichi-shi, Shiga 527-0038 (JP)
- **Imai, Hidetoshi**
  Yokaichi-shi, Shiga 527-0091 (JP)
- **Oshima, Yasuo**
  Koga-gun, Shiga 520-3331 (JP)
- **Fukushima, Masaichi**
  Omihachiman-shi, Shiga 527-0891 (JP)
- **Nakayama, Atsushi**
  Yamatokoriyama-shi, Nara 639-1014 (JP)

(74) Representative: **Grünecker, Kinkeldey, Stockmair & Schwanhäusser Anwaltssozietät**
Maximilianstrasse 58
80538 München (DE)

(54) Self-moving vacuum cleaner

(57) A self-moving cleaner has main body 1 comprising intake opening 9 for suctioning dust, electric blower 7 for generating airflow to suction the dust, dust receiver 10 for collecting the dust suctioned by the electric blower 7, rollers 11 driven by drive motors (3 and 4), power source 8 for supplying electric power to the electric blower 7 and the drive motors (3 and 4), sensors (2 and 12) for optically detecting a distance to an obstacle, and enclosure 16 containing therein the electric blower 7, the dust receiver 9, the power source 8, and the sensors (2 and 12), wherein the enclosure 16 is constructed transparent or semitransparent, and the sensors (2 and 12) transmit and receive light through the enclosure 16. Thus provided is the self-moving cleaner that can accurately detect a position of its own main body even with a reduced cost.

FIG. 1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a self-moving cleaner having a main body with self-moving function for automatically cleaning a surface to be cleaned.

BACKGROUND OF THE INVENTION

[0002] A self-moving cleaner hitherto known is provided with moving means for moving a main body, a direction sensor for detecting a moving direction of the main body, a distance sensor for measuring a distance to an obstacle around the main body, control means for controlling the moving means according to the direction sensor and the distance sensor, an electric blower for suctioning dust on a floor surface, and a battery serving as a power source for supplying electric power to the entire main body, wherein the cleaner first travels alongside of walls, and then travels inner area under control of the direction sensor. It has been a common practice to place detectable objects such as reflecting plates, markers, magnets that produce magnetism, antennas that generate radio waves, and the like on the walls of a room, in order to allow the cleaner recognize predetermined locations by detecting them with the sensors mounted to the main body. Otherwise, there has been a problem of requiring a complicated process for the cleaner to accurately detect a position of its own main body based on a moving direction and a distance of travel.

[0003] Besides, the main body is covered with an enclosure, which generally is opaque. It has therefore had another problem in which parts of the enclosure where light (i.e. infrared rays) pass through need to be constructed transparent in order for a plurality of sensors to transmit and receive the light (infrared rays) to detect a distance, thereby making the enclosure complex in structure and increase in cost.

SUMMARY OF THE INVENTION

[0004] A self-moving cleaner of this invention has a main body, which comprises an intake opening for suctioning dust covering a surface being cleaned, an electric blower for generating airflow to suction the dust, a dust receiver for collecting the dust suctioned by the electric blower, a roller defining moving means to be driven by a drive motor, a power source for supplying electric power to the electric blower and the drive motor, a sensor for optically detecting a distance to an obstacle, a heat source, and the like, and an enclosure containing the electric blower, the dust receiver, the power source, and the sensor, wherein the enclosure is constructed transparent or semitransparent, and the sensor transmits and receives light through the enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Fig. 1 is a perspective view of a self-moving cleaner representing a first exemplary embodiment of the present invention;
Fig. 2 is a plan view of a room depicting a travelling path alongside of walls;
Fig. 3 is a diagram designating moving directions;
Fig. 4 is a block diagram of controller;
Fig. 5 is a plan view of a room depicting a travelling path inside thereof according to a second exemplary embodiment of the invention;
Fig. 6 is another plan view of the room depicting a travelling path according to a third exemplary embodiment of the invention, after the cleaner has detected as having complete a full round;
Fig. 7 is another plan view of the room as the cleaner is standing in a corner thereof;
Fig. 8 is a plan view of the room, which pertains to a fourth exemplary embodiment of the invention;
Fig. 9 is another plan of the room, which pertains to a fifth exemplary embodiment of the invention;
Fig. 10 is still another plan view of the room, which pertains to a sixth exemplary embodiment of the invention; and
Fig. 11 is yet another plan view of the room, which pertains to a seventh exemplary embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0006] A first exemplary embodiment will be described hereinafter with reference to Fig. 1 through Fig. 4.

[0007] In Fig. 1, main body 1 is provided with intake opening 9 in a bottom forward section, and so constructed that it suctions dust covering a surface being cleaned through the intake opening 9. Electric blower 7 generates airflow to suction the dust, and it is in communication with the intake opening 9 through dust receiver 10 in such a manner that the dust suctioned by the electric blower 7 from the intake opening 9 is collected into the dust receiver 10.

[0008] A power source comprises battery 8 consisting of a plurality of rechargeable secondary batteries, and it supplies electric power to the electric blower 7 and drive motors, which will be described later. Distance sensor 2 emits light (i.e. infrared ray), and measures a distance according to an angle between the emitted light and reflected light returned from an obstacle such as home furniture. There are plurality of distance sensors 2 mounted to a forward section, sides, and a rear section of the main body 1. Level sensor 12 detects a difference in level of the surface (i.e. floor surface) to be cleaned. The level sensor 12 is constructed into a like structure

as the distance sensor 2, and it is mounted to each corner of the main body 1 in a manner to face slantingly downward.

[0009] Rollers 11 serve as travelling means for moving the main body 1. They are mounted to both right and left sides of the main body 1, and driven independently by right drive motor 3 and left drive motor 4. Each of the drive motors comprises a geared motor having a built-in reduction gear (not show in the figure).

[0010] Panel switch 14 mounted to an upper surface of the main body 1 has a function of displaying characters and the like, as well as a function of turning on and off when it is touched. First indicators 18 display a state of detection made by the distance sensors 2 and the level sensors 12. They consist of light emitting diodes, and each is mounted above every one of the level sensors 12 mounted to the corners of the main body 1 of the cleaner. Second indicator 13 displays operating conditions of the electric blower 7, the drive motors and the like, as well as a state when the main body 1 stops operation, and it is mounted to the upper surface of the main body 1. It consists of light emitting diodes or display panels like liquid-crystal panels.

[0011] The panel switch 14 and the indicator 13 are connected with a controller, and they are so constructed that the controller controls operation of the electric blower 7, the drive motors and the like when the user touches the panel switch 14, to move the cleaner automatically with the rollers 11 driven by the drive motors while suctioning dust by the electric blower 7, and it stops at least the drive motors 3,4 when the user touches a certain part of the panel switch 14 in case of emergency during automatic travelling. A reference numeral 15 represents a power supply switch. The controller consists of microcomputers having travel control means 6 for controlling the drive motor 3 and 4.

[0012] The main body 1 houses therein the intake opening 9, electric blower 7, dust receiver 10, battery 8 serving as the power supply, right drive motor 3, left drive motor 4, distance sensors 2, level sensors 12, and the like, and it is covered by transparent enclosure 16. The distance sensors 2 and the level sensors 12 thus transmit and receive light (i.e. infrared rays) through the enclosure 16. The level sensors 12 transmit and receive the light (infrared rays) through protruding portions 17 where parts of the enclosure 16 are protruded, since they are mounted to these corners of the main body 1 in a manner to face slantingly downward. The enclosure 16 may be constructed semitransparent. This ensures reliable operation of the sensors for detecting a distance by transmitting and receiving the light (infrared rays), and allows the self-moving cleaner to get around an obstacle and the like while travelling, so as to improve travelling performance and to provide the self-moving cleaner with the enclosure of simple structure while reducing the cost at the same time. The distance sensors 2 or the level sensors 12 may detect heat sources. And the results may be displayed on the second indicator 13. This advises the user to remove obstacles, for instance children or pets, which they detect at the starting the automatic travelling

[0013] The travelling operation is now described referring to Fig. 2 through Fig. 4.

[0014] In Fig. 2, the cleaner starts to travel at point A. The cleaner moves to turn the main body 1 when it detects an obstacle at point B with distance sensor 2-1 mounted to a forward section. While it travels along the obstacle using distance sensors 2-2 and 2-3 mounted to its one side, it determines that a parallel orientation is established at a point when outputs of the distance sensors 2-2 and 2-3 are generally in an equal condition. Assuming that the main body 1 takes an orientation in parallel with a wall at point C, the heading direction at this point is designated as a reference direction, to which the main body 1 travels, in direction sensor 5 for detecting a moving direction of the main body 1. Directions to be determined are designated as reference direction "0", direction "1", direction "2" and direction "3" at approximately every 90° in a clockwise order, as shown in Fig. 3. As the cleaner travels along the wall thereafter, the direction sensor 5 determines that the cleaner has completed a full round along walls of the room when it has traveled for a predetermined time "T" from point G to point H, after the direction sensor 5 detects the reference direction "0". Although the cleaner takes an orientation of the reference direction "0" when there is an obstacle shown by slant lines, the direction sensor 5 does not make detection of a complete round, since the cleaner has not as yet traveled for the predetermined time "T". This has an advantage of not requiring special means of detection for completing a full round through the walls of the room. The direction sensor 5 comprises an angular velocity sensor using gas flow method, vibrating method, optical method or the like.

[0015] In addition, the cleaner is provided with battery capacity detection means for detecting a capacity of the battery 8 which provides power supply to the main body 1. It turns off the electric blower 7 for suctioning dust on the floor surface, moves the cleaner along the walls up to a predetermined location and stops the cleaner, when capacity of the battery 8 is reduced. Accordingly, this can provide the self-moving cleaner, which does not stay in an unexpected place to obstruct traffic.

[0016] Described next is a second exemplary embodiment of this invention referring to Fig. 2 and Fig. 5. Like reference numerals are used to designate like structural components as those of the first exemplary embodiment, and their details are skipped. The cleaner first travels alongside of walls. It then travels inner area of a room while moving back and forth in a predetermined direction and another direction opposite it using direction sensor 5, after determination that it has completed a full round along the walls of the room. It can travel and clean dust throughout the room, as it collects the dust in corners of the room while travelling alongside of the walls, and suctions the dust inside of the room while

travelling the inner area with guide of the direction sensor 5.

[0017] A third exemplary embodiment of this invention is described next with reference to Fig. 6 and Fig. 7. Again, like reference numerals are used to designate like structural components as those of the first exemplary embodiment, and their details are skipped. The cleaner first travels alongside of walls, and thereafter it travels an inner area as guided by direction sensor 5. It again travels alongside of the walls, moves toward the inner area of room at point "H" after determination that it has completed a full round along the walls of the room, and turns off electric blower 7, drive motors 3 and 4 to stop the travel at point "I". There is a case that a door can not be opened as main body 1 obstructs opening and closing of the door, if the main body 1 stops travelling near the wall as shown in Fig. 7 where there is the door that opens inside. A problem of this kind is avoided, however, by making the main body 1 to stop travelling only after it has moved to the inner area of the room.

[0018] In Fig. 6, the cleaner first travels alongside of the walls, travels the inner area thereafter as guided by the direction sensor 5, again travels alongside of the walls, moves toward the inner area of the room at point "H" after determination that it has completed a full round along the walls of the room, and turns off the electric blower 7, the drive motors 3 and 4, to stop travelling at point "I" where distance sensor 2-5 mounted to an upper section of the main body 1 does not detect any obstacle above it. If the main body 1 travels beneath a bed or a desk, for instance, and stops moving, it gives rise to a problem, because the main body 1 hides itself under the bed or the desk, that requires the user to locate it when he/she is to use it again. However, the above problem can be cleared by allowing it to move only to an area where there is no obstacle above it when it stops travelling.

[0019] Furthermore, in Fig. 6, the cleaner first travels alongside of the walls, travels the inner area thereafter as guided by the direction sensor 5, again travels alongside of the walls, moves toward the inner area of the room at point "H" after determination that it has completed a full round along the walls of the room, and turns off the electric blower 7, the drive motors 3 and 4, to stop traveling at point "I" where distance sensor 2-5 mounted to an upper section of the main body 1 does not detect any obstacle above it. During this moment, the cleaner turns itself by 360° to determine if there is any obstacle around it, and stops operation only when it finds no obstacle. There is a case that a door can not be opened as the main body 1 obstructs opening and closing of the door, if it stops travelling near the wall where there is the door that opens inside, as shown in Fig.7. A problem as described here can be avoided by making the main body 1 turn 360° to detect presence or absence of any obstacle around it, and stop operation only when there is no obstacle, when the main body 1 moves toward the inner area of the room and stops travelling.

[0020] Referring to Fig. 8, a fourth exemplary embodiment of the invention is described next. Like reference numerals are used to designate like structural components as those of the first exemplary embodiment, and their details are skipped. When the cleaner travels alongside of walls by controlling right drive motor 3 and left drive motor 4 using an output of distance sensor 2-2 mounted to its right side, it reduces rotational speeds of the right drive motor 3 and the left drive motor 4 in a manner to decelerate the travelling speed, when a distance to a detected wall obtained from an output of distance sensor 2-1 mounted to the forward section is smaller than first prescribed value L1. In addition, it controls the right drive motor 3 into forward rotation and the left drive motor 4 into reverse rotation in a manner to make a counterclockwise turn, when a distance to the detected wall obtained from subsequent output of the distance sensor 2-1 becomes smaller than second prescribed value L2, which is smaller than the first prescribed value L1. The above is a case when the cleaner makes a turn inside a corner. The cleaner can turn smoothly in the corner without hitting the wall, when the travelling speed is reduced in advance to avoid it from hitting the wall ahead, and by presetting the second prescribed value L2 used for comparison with the output of the distance sensor 2-1 mounted to the forward section of the main body 1 to such a value as to eliminate a chance of the main body 1 hitting the wall in front of it during its turning movement.

[0021] Next, a fifth exemplary embodiment of the invention is described referring to Fig. 9. Again, like reference numerals are used to designate like structural components as those of the first exemplary embodiment, and their details are skipped. When the cleaner travels alongside of walls by controlling right drive motor 3 and left drive motor 4 using an output of distance sensor 2-2 mounted to its right side, it reduces rotational speeds of the right drive motor 3 and the left drive motor 4 in a manner to decelerate the travelling speed, when an output of distance sensor 2-1 mounted to the forward section represents a value nearer than first prescribed value L1. In addition, it controls the right drive motor 3 into forward rotation and the left drive motor 4 into reverse rotation, while maintaining their speeds equal, in a manner that the cleaner turns counterclockwise by approximately 90° when the subsequent output of the distance sensor 2-1 shows a value smaller than second prescribed value L2. In other words, the cleaner in its position makes a turn of approx. 90° about a center of axis at a mid point between the right drive motor 3 and the left drive motor 4. Upon completion of the approx. 90° turn, it further makes another turn of 90° by driving both the right drive motor 3 and the left drive motor 4 into forward rotation with only the left drive motor 4 rotated slower. When the cleaner is turned by approximately 180° in this manner, it is situated adjoining the track it has traveled on its way, but in a direction opposite to it. It travels thereafter again toward the opposite di-

rection according to the output of the direction sensor 5.

[0022] In making the second turn of approx. 90° here (i.e., both the right drive motor 3 and the left drive motor 4 make forward rotation, with a speed of the left drive motor 4 reduced), there can be reduced to a great extent possible an area where the cleaner fails to sweep through in the forward and the backward passages, when it is turned slightly more than 90°, and moved it thereafter in the opposite direction according to an output of the direction sensor 5.

[0023] Furthermore, with regard to a relation between a travelling speed of the cleaner when it travels alongside of the walls by being controlled with an output of the distance sensor 2 mounted to the side of it and another travelling speed when it travels in the predetermined direction within the inner area of the room according to the direction sensor 5, the former is set slower than the latter. This decreases a frequency of the cleaner to collide with the walls since it is closer to these obstacles when travelling along the walls, and reduces a chance of damaging the walls and the like. In addition, it also has an advantageous effect of cleaning slowly and thoroughly the entire areas near the walls where dust has usually collected.

[0024] A sixth exemplary embodiment of the invention is described now with reference to Fig. 10. Like reference numerals are used throughout to designate like structural components as those of the first exemplary embodiment, and their details are skipped. At first, the cleaner travels as same as the second exemplary embodiment. When the cleaner detects an obstacle at point J with distance sensor 2-4 mounted to its left side, it turns approximately 180° into an opposite direction, and continues thereafter to travel the way back in the opposite direction according to an output of direction sensor 5. The self-moving cleaner provided here stops its operation when it detects an obstacle at point K with distance sensor 2-3 mounted to its right side, where it determines that the obstacle is a wall of the room and that it has traveled throughout the interior of the room according to its function of travelling the room with guide of the direction sensor.

[0025] A seventh exemplary embodiment of the invention is described now with reference to Fig. 11. Like reference numerals are used throughout to designate like structural components as those of the first exemplary embodiment, and their details are skipped. When the cleaner starts travelling and detects an obstacle with distance sensor 2-1 mounted to the forward section, it moves in a manner to turn main body 1 by 360°, and it diagnoses itself for any abnormality by examining outputs of distance sensors 2 mounted to a periphery of the main body 1 using the facing wall. There is thus provided a self-moving cleaner which can find malfunction of the distance sensors 2, and improves safety by not starting itself into moving operation if it finds a failure in any of the distance sensors 2.

Claims

1. A self-moving cleaner having a cleaner main body, said cleaner main body comprising:

   an intake opening for suctioning dust collected on a surface being cleaned;
   an electric blower for generating airflow to suction the dust;
   a dust receiver for collecting the dust suctioned by said electric blower;
   a roller defining moving means driven by a drive motor;
   a power source for supplying electric power to said electric blower and said drive motor;
   a sensor for optically detecting a distance to an obstacle; and
   an enclosure containing therein said electric blower, said dust receiver, said power source, and said sensor,

   wherein said enclosure is constructed to be transparent or semitransparent, and
   said sensor transmits and receives light through said enclosure.

2. The self-moving cleaner as set forth in claim 1 further comprising indicator for displaying at least one of below:

   1) a state of detection of said sensor
   2) an operating condition of at least one of said electric blower and said drive motor.

3. The self-moving cleaner as set forth in claim 2, wherein said indicator comprises first indicator for displaying the state of detection of said sensor and second indicator for displaying the operating condition of at least one of said electric blower and said drive motor.

4. The self-moving cleaner as set forth in claim 1, wherein said sensor is mounted to a corner of said cleaner main body as viewed from above said main body.

5. The self-moving cleaner as set forth in claim 1, wherein said sensor is mounted to a forward section of said main body.

6. The self-moving cleaner as set forth in claim 5 further comprising:

   a direction sensor for detecting a moving direction of said main body;
   another plurality of sensors mounted to the side of said main body for optically detecting a distance to an obstacle; and

travel control means for controlling said moving means according to an output of said direction sensor, said sensor mounted to a forward section of said main body ,and said sensors mounted to the side of said main body,

wherein said cleaner:

causes said main body to turn and travels alongside of a wall of a room when said sensor mounted to a forward section of said main body detects the wall;
designates as a reference direction a direction of move in progress at a timing when outputs of said sensors mounted to the side of said main body are generally in agreement, and sets as a reference for output of said direction sensor; and
determines that said cleaner has completed a full round alongside of walls of the room, when said cleaner has traveled thereafter for a predetermined time after said direction sensor has detected said cleaner as being in an orientation of the reference direction.

7. The self-moving cleaner as set forth in claim 6, wherein said cleaner:

travels in a predetermined direction in the room according to an output of said direction sensor after determination that said cleaner has completed a full round along the walls of the room;
causes said main body to turn round and travels in a second direction when any of said sensor mounted to the forward section detects an obstacle; and
again causes said main body to turn round when said sensor mounted to the forward section detects another obstacle, and travels back and forth in said predetermined direction and said second direction.

8. The self-moving cleaner as set forth in claim 6, wherein said cleaner:

travels in a predetermined direction in the room according to an output of said direction sensor;
causes said main body to turn round and travels in a second direction when said sensor mounted to the forward section detects an obstacle;
again causes said main body to turn round when said sensor mounted to the forward section detects a wall, and travels back and forth in said predetermined direction and said second direction;
upon completion of the foregoing operating steps, travels again alongside of the walls of the room; and
moves toward an inner area of the room and turns off a load, after determination that said cleaner has completed a full round along the walls of the room.

9. A self-moving cleaner comprising:

a main body;
moving means for moving said main body;
direction sensor for detecting a moving direction of said main body;
distance sensors disposed to a forward section and the side of said main body for measuring a distance to an obstacle around said main body;
travel control means for controlling said moving means according to an output of said direction sensor and any of said distance sensors; and
a battery defining a power source,

wherein said cleaner:

causes said main body to turn, and travels alongside of a wall of a room when any of said distance sensors mounted to the forward section of said main body detects said wall;
designates as a reference direction a direction of move in progress at a timing when outputs of a plurality of said distance sensors mounted to the side of said main body are generally in agreement, and sets as a reference for output of said direction sensor; and
determines that said cleaner has completed a full round alongside of walls of the room, when said cleaner has traveled thereafter for a predetermined time after said direction sensor has detected said cleaner as being in an orientation of the reference direction.

FIG. 1

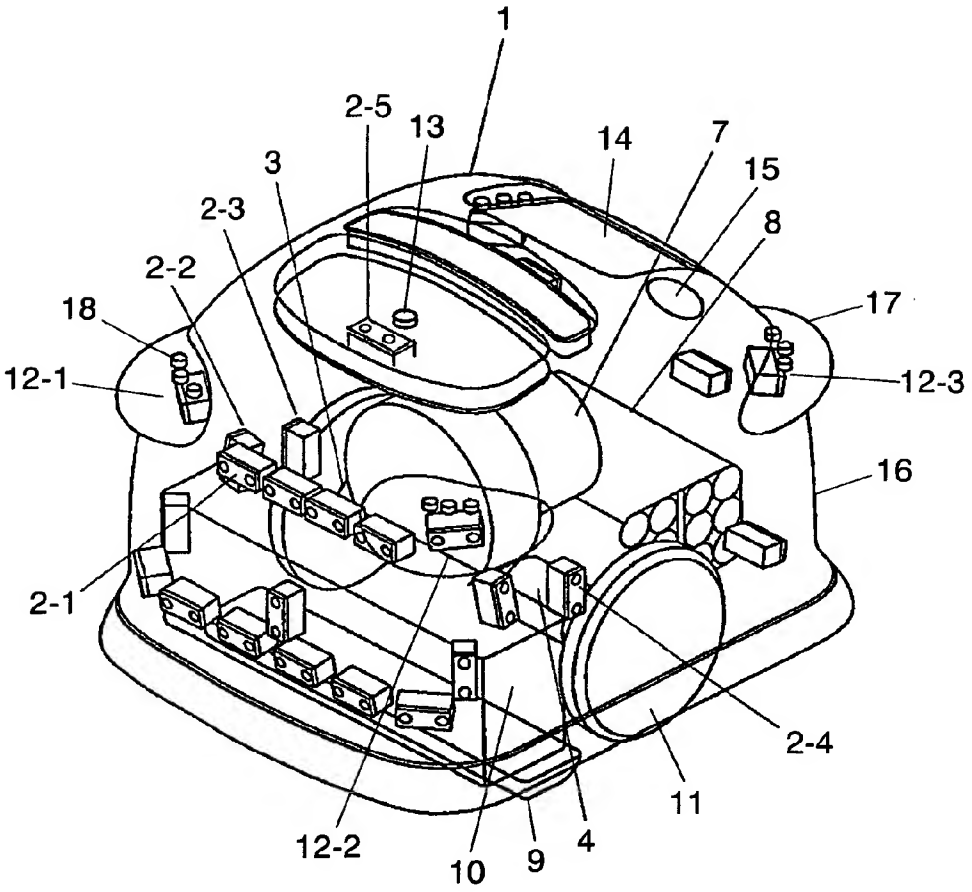


FIG. 2

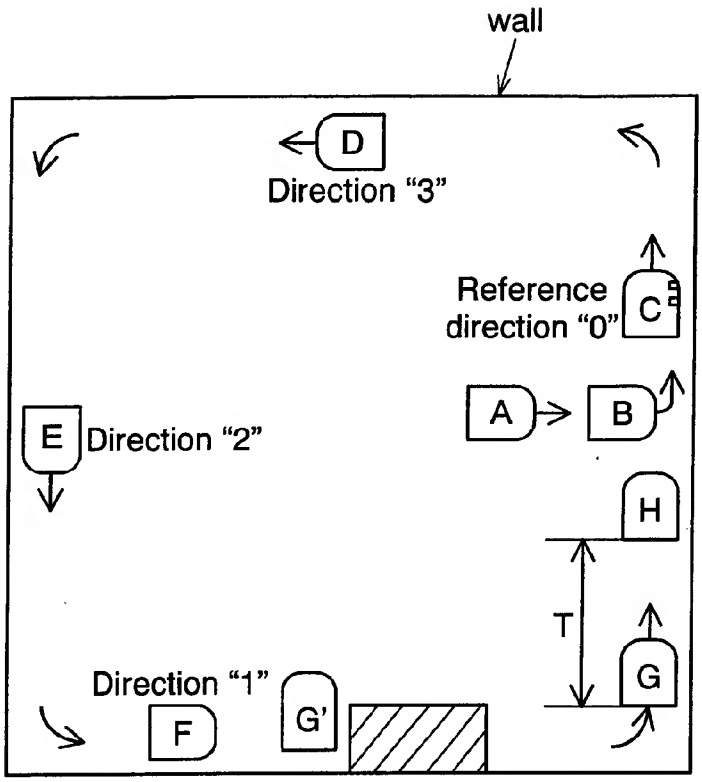

wall
D
Direction "3"
Reference
direction "0"
C
A
B
E
Direction "2"
H
T
G
Direction "1"
G'
F

FIG. 3

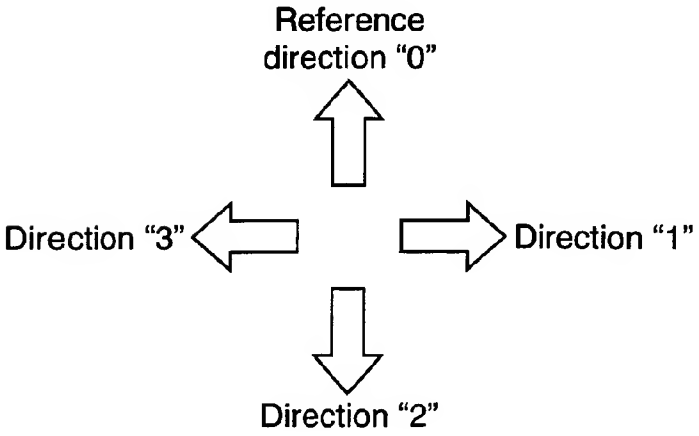

Reference
direction "0"
Direction "3"
Direction "1"
Direction "2"

FIG. 4

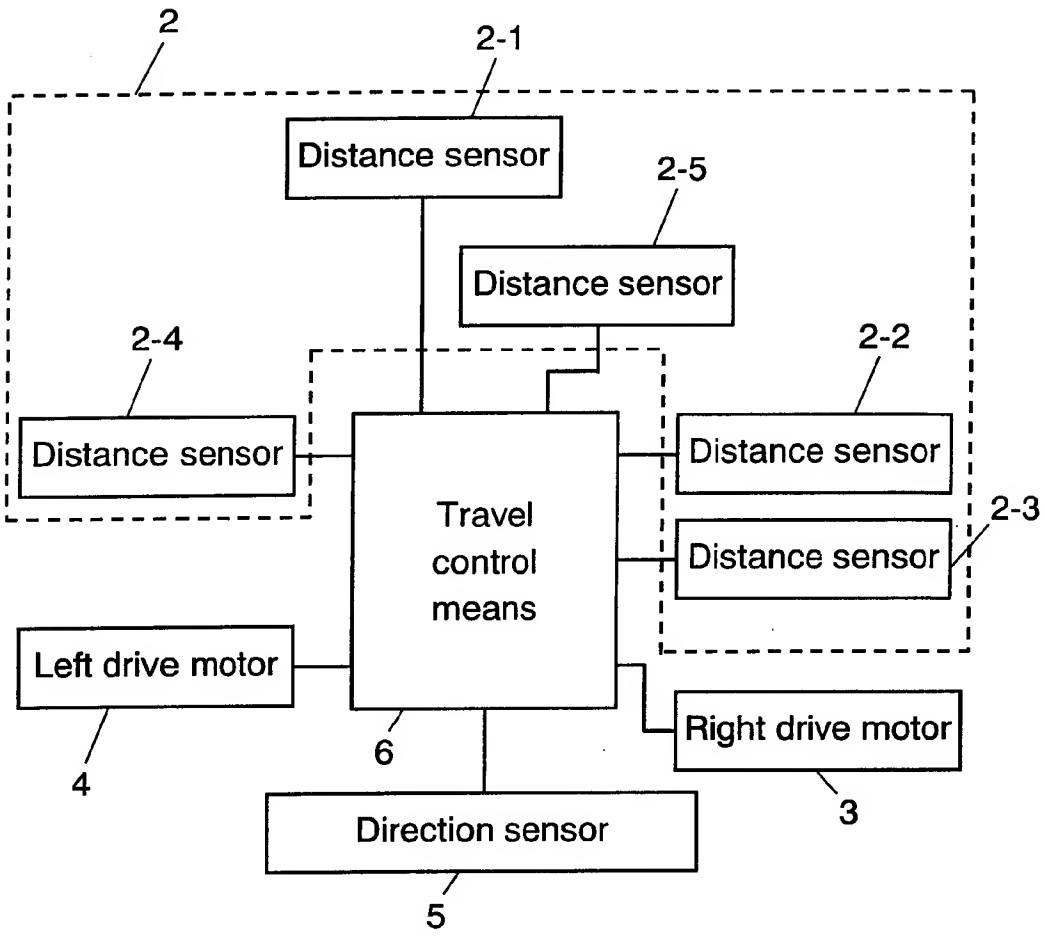

2
2-1
Distance sensor
2-5
Distance sensor
2-4
2-2
Distance sensor
Distance sensor
2-3
Travel control means
Distance sensor
Left drive motor
Right drive motor
4
6
3
Direction sensor
5

FIG. 5

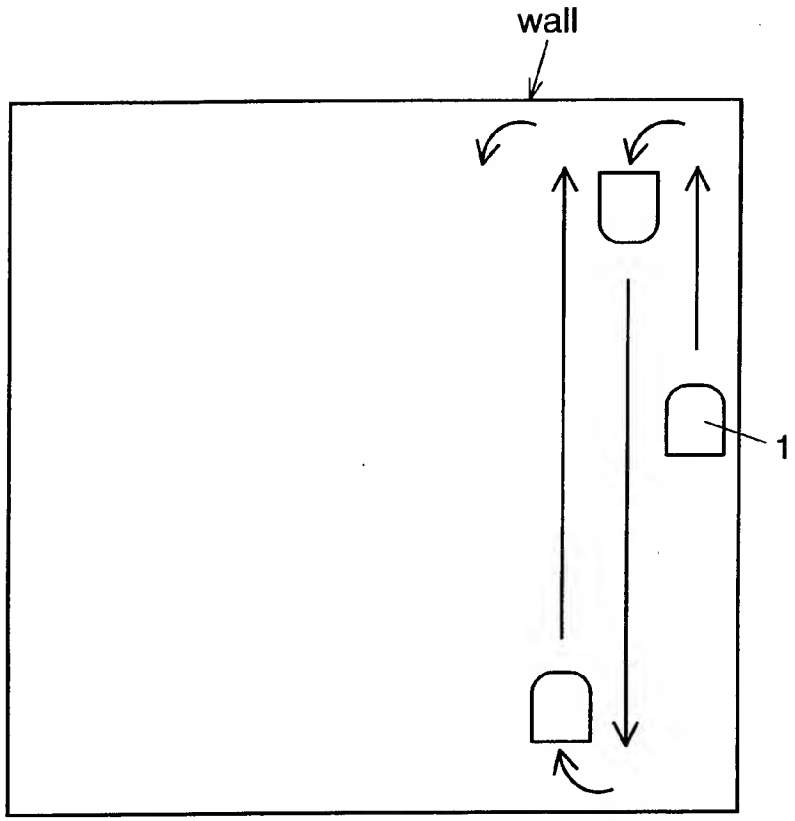


FIG. 6

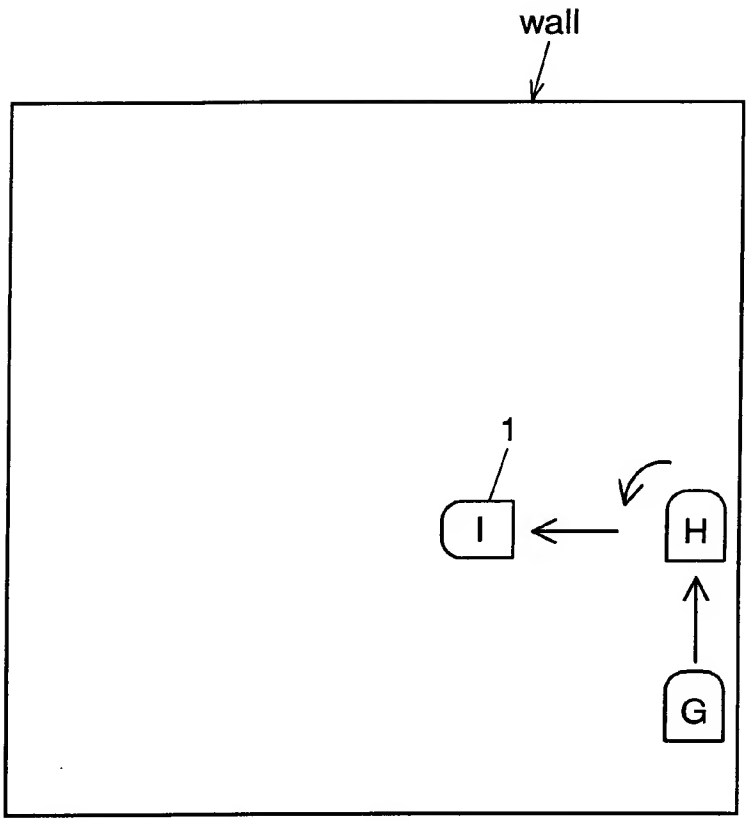


FIG. 7

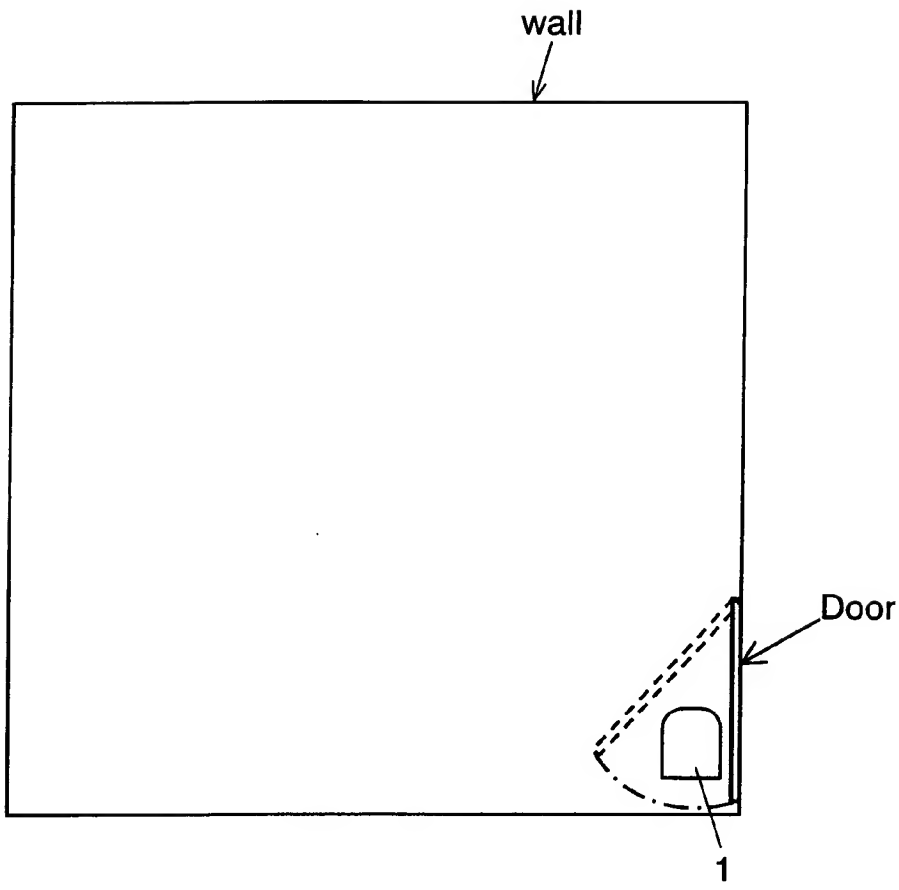


FIG. 8

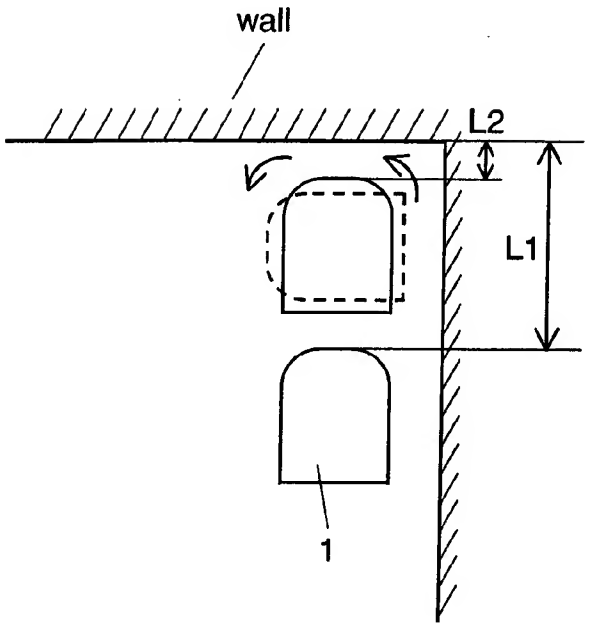


FIG. 9

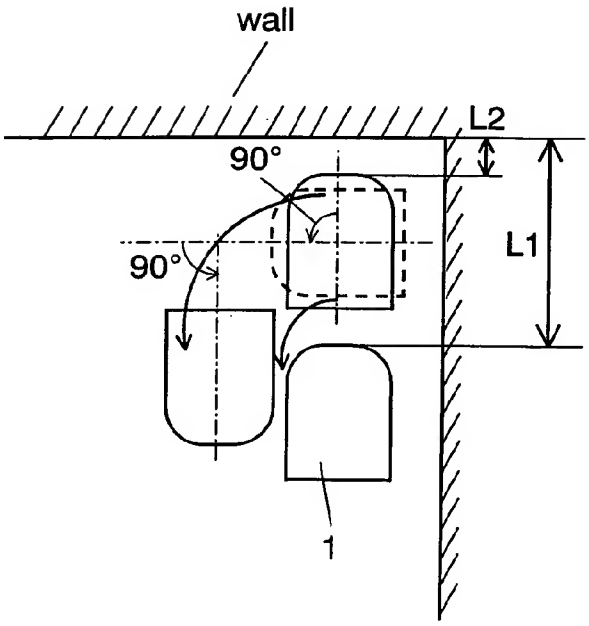


FIG. 10

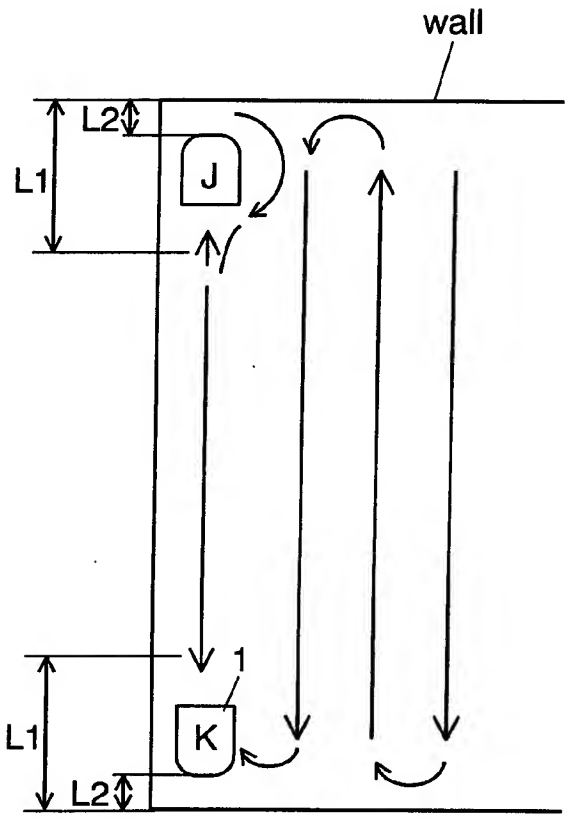
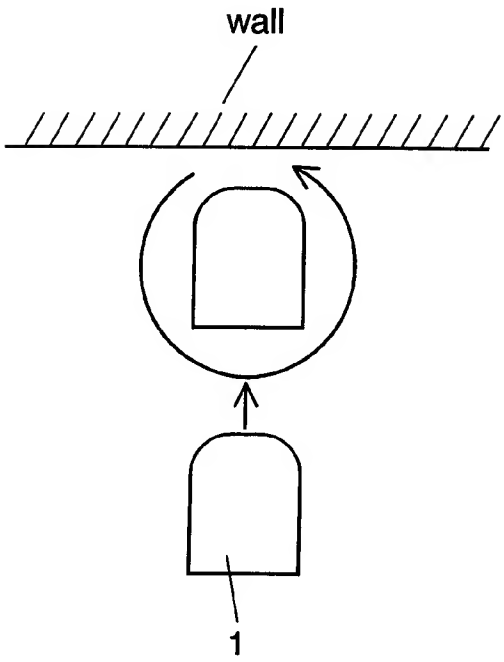


FIG. 11



Key to Reference Alphanumeric Characters

1	main body
2,2-1,2-2,2-3,2-4,2-5	distance sensor
3	right drive motor
4	left drive motor
5	direction sensor
6	travel control means
7	electric blower
8	battery
9	intake opening
10	dust receiver
11	rollers
12,12-1,12-2,12-3	level sensor
13	second indicator
14	panel switch
15	power supply switch
16	enclosure
17	protruding portion
18	first indicator